Revision of *Plummerita* Brönnimann (Foraminiferida) and a new Maastrichtian species from Ecuador

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Synopsis

Plummerita is emended to include all rugoglobigerinid foraminifera with tubulospinose chambers in the final whorl. The genus, formerly monotypic, now includes *P. hantkeninoides* (Brönnimann) the type-species, *P. reicheli* (Brönnimann) and a new species, *P. kennerleyi*, from Ecuador.

Introduction

Plummerita Brönnimann (1952*a*) was erected as a new name for *Plummerella* Brönnimann, 1952 (*non Plummerella* De Long, 1942). Originally a subgenus of *Rugoglobigerina*, it was raised to generic status by Brönnimann & Brown (1956). Until now it contained but one species and three subspecies, *P. hantkeninoides hantkeninoides*, *P. h. costata* and *P. h. inflata*, defined by Brönnimann (1952) on the degree of inflation of the later-formed chambers of the final whorl and variation in what he termed the 'hantkeninoid' portion of the test; this development of 'spinose' chambers in the axis of coiling readily distinguishing *Plummerita* from *Rugoglobigerina*. The 'spines' of *Plummerita*, however, are more correctly termed tubulospines, as originally defined by Montanaro Gallitelli (1955 : 142) in connection with the genus *Schackoina*. That is, they are hollow, spine-like extensions of the chambers (see Figs 12, 17, p. 293); they are connected internally with the chamber cavity and are not solid as are true spines.

That *Plummerita* and *Rugoglobigerina* are closely related is unquestionable, since both have the same type of surface ornamentation and apparently the same apertural features. In spite of Bolli, Loeblich & Tappan's (1957) original misgivings that the development of chamber elongation and tubulospinosity '. . . were only sufficient to warrant specific separation' (1957 : 44), Loeblich & Tappan (1964) accorded *Plummerita* generic status, as did Masters (1977). The value of tubulospines in the classification of planktonic foraminifera, however, remains uncertain. It is now generally accepted that *Plummerita* is distinct from *Rugoglobigerina*, but on the other hand a new genus based on the only tubulospinose *Globotruncana*, *G. calcarata* Cushman, is not warranted.

Recently a remarkable new species, showing elongation of the chambers in different planes to the axis of coiling and with more than one tubulospine per chamber, has been discovered in the Ecuadorian Andes. These features are unlike anything seen in *Plummerita hantkeninoides* (Brönnimann). Rather than propose a new genus I prefer to emend the diagnosis of *Plummerita* to incorporate all tubulospinose species of *Rugoglobigerina*. The new species is named *P. kennerleyi*. Following the suggestion of Masters (1977), *Rugoglobigerina reicheli* Brönnimann is transferred to *Plummerita*, this species showing radial elongation of the chambers and tubulospines in the final whorl, features not found in any other *Rugoglobigerina*.

Topotypes of *P. hantkeninoides* from the Maastrichtian of Trinidad were studied for comparison with *P. kennerleyi*. The opportunity is taken to illustrate the type species by scanning electron microscopy for the first time, and to show intraspecific variability (Figs 2–10, 16). *P. reicheli* is also re-illustrated from type material (Fig. 11).

Acknowledgements

I am particularly indebted to Professor P. Brönnimann, of the University of Geneva, for his generous help in the preparation of this paper and for supplying the specimens of *Plummerita hantkeninoides* and *P. reicheli* from the Guayaguayare Formation of Trinidad. The assistance in the field

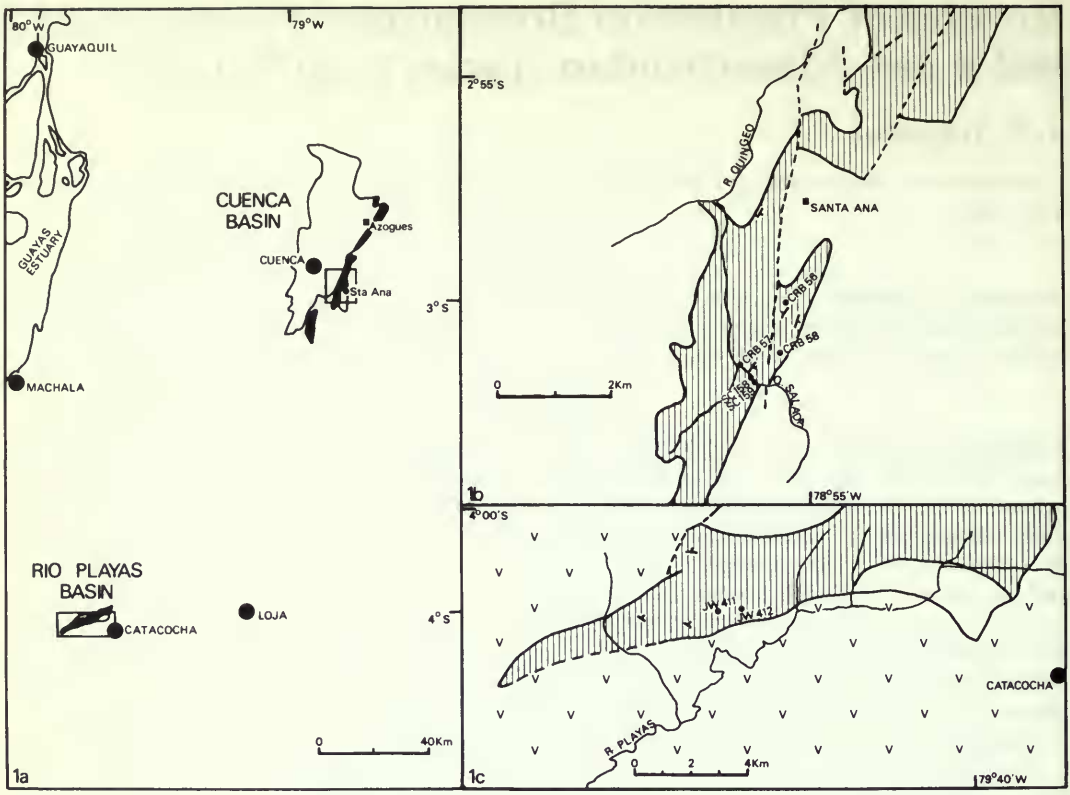


Fig. 1 Locality map. 1a, The Río Playas and Cuenca Basins, south Ecuador; areas shown in detail in Figs 1b, c, are outlined. Figs 1b, c, parts of the Cuenca and Río Playas Basins, respectively. Outcrop of late Cretaceous sediments is indicated by vertical shading; occurrence of *Plummerita kennerleyi* sp. nov. by dots; areas left blank are Tertiary sediments; V = volcanic rocks. (Geology taken from Cariamanga and Gualaceo Sheets, D.G.G.M. 1973–4).

of Dr C. R. Bristow and the late J. B. Kennerley, Institute of Geological Sciences (Overseas Division), London, was much appreciated. My colleagues Dr C. G. Adams and R. L. Hodgkinson are thanked for their critical reading of the manuscript and for their technical assistance, respectively. The SEM photographs were taken by the author and printed by P. P. Lund of the Department of Central Services, British Museum (Natural History). Finally, my wife is thanked for drafting Fig. 1.

Material

All the material illustrated in this paper is housed in the collections of the Protozoa Section, Department of Palaeontology, British Museum (Natural History), London; registered numbers are P 50829–P 50840 inclusive.

Plummerita in Ecuador

Late Cretaceous sediments crop out in several basins within the Ecuadorian Sierra (Andes), in the southwestern Coastal Provinces and in the Oriente to the east of the Andean mountain chain. *Plummerita kennerleyi* sp. nov., however, has only been found so far in the Cuenca and Río Playas Basins (Fig. 1a) described below.

The Cuenca Basin

The Cuenca Basin is the largest Tertiary sedimentary basin of the Ecuadorian Sierra and contains important late Cretaceous sediments which are referred to the Yunguilla Formation (see

Bristow 1973 and Bristow & Hoffstetter 1977, for an explanation of the stratigraphic nomenclature). Most of the recent work in the area has been undertaken by members of the Institute of Geological Sciences (Overseas Division), London (I.G.S.) and three of the samples (CRB 56–58) containing the new species of *Plummerita* were collected in 1972 by Dr C. R. Bristow (I.G.S.). Samples SC 158, 159 came from the collections of the Dirección General de Geología y Minas, Quito, and were collected earlier by a French Technical Aid Mission. Fig. 1b shows these localities in the southeastern part of the Basin just to the south of the small town of Santa Ana. All samples are of black shales from the 'Grupo superior', near the top of the (exposed) Yunguilla Formation, the best material coming from the Quebrada Salada where the shales are particularly friable and the foraminifera easiest to extract. The marine Yunguilla Formation is overlaid unconformably by the Loyola Formation of mid-Miocene age; this and subsequent Tertiary sediments were deposited in brackish or fresh water.

The age of the *Plummerita*-bearing sediments cannot be other than late Cretaceous on the associated foraminifera which include *Gavelinella plummerae* Tappan, *Gavelinella* sp., *Praebulimina joaquinensis* (Martin), *Praebulimina* sp., *Siphogenerinoides revoluta* Stone, *S. parva* Cushman, *S. bramletti* Cushman, *Brizalina* cf. *selmaensis* (Cushman), *Gaudryina laevigata* Franke, and the planktonic species *Heterohelix striata* (Ehrenberg), *H. globulosa* (Ehrenberg), *Hedbergella* spp. and *Rugoglobigerina rugosa* (Plummer). Of these, *Rugoglobigerina rugosa* and *Heterohelix striata* have the shortest stratigraphical range (Santonian to Maastrichtian according to Masters, 1977), although it is probable that the first appearance of the large benthic species *Siphogenerinoides revoluta* is within the Campanian. However, early Maastrichtian ammonites — *Sphenodiscus peruvianus* Gerth and *Solenoceras* sp., identified by Dr M. K. Howarth, British Museum (Natural History) — from the 'Grupo inferior' of the Yunguilla Formation indicate that the age of *Plummerita kennerleyi* in the Cuenca Basin must be either mid or late Maastrichtian.

The Río Playas Basin

This small Andean basin lies some 130 km to the southwest of the Cuenca Basin, just west of Catacocha (Fig. 1c). The sediments, originally studied by Kennerley (1973), are mainly of late Cretaceous age and are very similar in facies and fauna to the Yunguilla Formation farther north. Termed locally the Río Playas Formation, the strata include black shales and some softer, lighter-coloured mudstones with foraminifera. These are in turn overlaid unconformably by brightly coloured freshwater clays and conglomerates of presumed younger Tertiary age (see Bristow & Hoffstetter 1977 : 270). The Río Playas Basin is surrounded by various Cretaceous volcanic rocks.

Two samples, JW 411 and 412, collected by the author in 1974 from the Río Playas Formation, were found to contain *Plummerita kennerleyi*. The localities are shown in Fig. 1c. The associated foraminifera are almost identical to those found with the new species in the Cuenca Basin, and comprise *Gavelinella* sp., *Praebulimina joaquinensis* (Martin), *Siphogenerinoides revoluta* Stone, *S. parva* Cushman, *Anomalinoides* cf. *padella* Jennings, *Brizalina* cf. *selmaensis* (Cushman), *Lenticulina* sp. and the planktonic species *Heterohelix globulosa* (Ehrenberg), *Pseudotextularia elegans* (Rzehak), *Hedbergella* spp. and *Rugoglobigerina rugosa* (Plummer). According to Masters (1977), *Pseudotextularia elegans* is restricted to the Maastrichtian, thus strongly suggesting that *P. kennerleyi* must also be a Maastrichtian species and that the Río Playas specimens are coeval with those from the Cuenas Basin.

Systematics

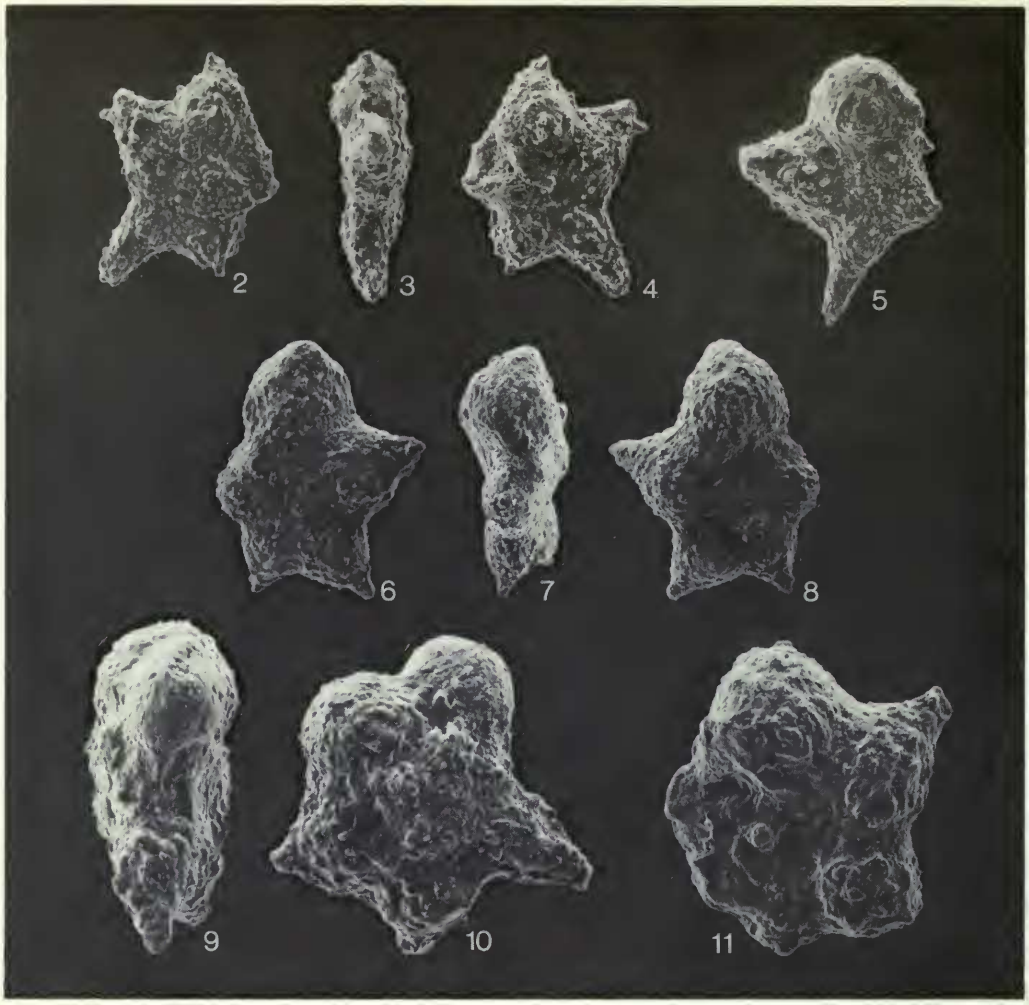
Superfamily **GLOBIGERINACEA** Carpenter, Parker & Jones, 1862

Family **GLOBOTRUNCANIDAE** Brotzen, 1942

Genus ***PLUMMERITA*** Brönnimann, 1952, emend.

TYPE SPECIES. *Rugoglobigerina* (*Plummerella*) *hantkeninoides hantkeninoides* Brönnimann, 1952.

EMENDED GENERIC DIAGNOSIS. Similar to *Rugoglobigerina* in form but with chambers of the last whorl becoming elongate and developing single or paired tubulospines.



Figs 2–10 *Plummerita hantkeninoides* (Brönnimann). Figs 2–8, topotypes, identified by Brönnimann as *P. hantkeninoides hantkeninoides* (Brönnimann), Guayaguayare Formation, SE Trinidad. Figs 2–4, P 50829, spiral, edge (abapertural) and umbilical views; Fig. 5, P 50830, spiral view; Figs 6–8, P 50831, spiral, edge (apertural) and umbilical views. Figs 9, 10, topotypes, identified by Brönnimann as *P. hantkeninoides costata* (Brönnimann), Guayaguayare Formation, SE Trinidad. P 50832, edge (apertural) and spiral views. All specimens ×135.

Fig. 11 *Plummerita reicheli* (Brönnimann). P 50833. Paratype, umbilical view. Guayaguayare Formation, SE Trinidad. ×135.

DESCRIPTION. Test a compressed to moderately inflated low trochospire; outline in spiral and umbilical views lobulate becoming tubulospinate, or tubulospinate throughout; in edge view, periphery rounded or tubulospinose. Chambers of early whorls subspherical, within final whorl becoming elongate either in the plane of coiling or oblique to it with development of single or paired tubulospines. If one tubulospine per chamber, it extends outward from mid-line of each chamber on the periphery; if paired, at opposite margins of the periphery. Terminal and penultimate chambers often inflated and sometimes lacking tubulospines. Surface of test ornamented with meridionally arranged fine to coarse ridges, or lines of course (true) spines or nodes; pores numerous. Tubulospines of various lengths and thicknesses, hollow, with rugose or ridged ornament; perforate. Aperture appears to be a low interiomarginal, umbilical–extraumbilical arch. Umbilicus shallow and usually narrow, tegillum present but rarely preserved.

Plummerita hantkeninoides (Brönnimann)
Figs 2–10, 16

1952 *Rugoglobigerina* (*Plummerella*) *hantkeninoides hantkeninoides* Brönnimann: 37; pl. 3, figs 1–3; text-fig. 17.
1952 *Rugoglobigerina* (*Plummerella*) *hantkeninoides costata* Brönnimann: 39; pl. 3, figs 4–6; text-fig. 18.
1952 *Rugoglobigerina* (*Plummerella*) *hantkeninoides inflata* Brönnimann: 40; pl. 3, figs 7–9; text-fig. 19.
1977 *Plummerita hantkeninoides* (Brönnimann); Masters: 617 (*q.v.* for synonymy).

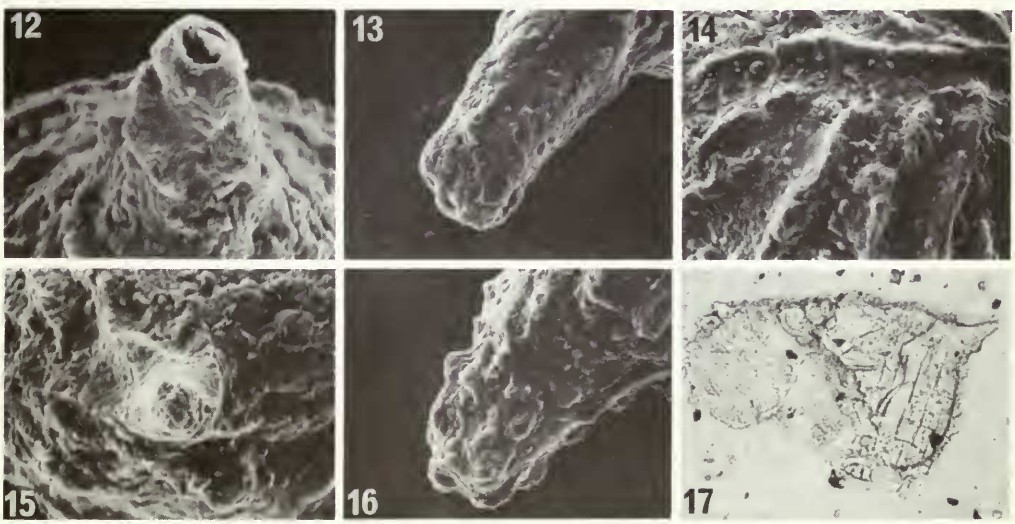
MATERIAL. About 20 topotypic specimens from the Guayaguayare Formation, Guayaguayare Well no. 163, core 19, depth 5588–5598 feet (1703–1706 m), SE Trinidad.

DIMENSIONS. Figured specimens: maximum diameter (including tubulospines) varies between 0·25 and 0·33 mm; greatest width 0·09–0·13 mm.

REMARKS. Nothing new can be added to the original description. The three subspecies occur together, have identical ranges, and are best considered as growth stages within a single species. Topotypes identified by Brönnimann as *P. hantkeninoides hantkeninoides* and *P. hantkeninoides costata* are figured here (Figs 2–8 and 9–10, respectively). Because of their state of preservation, the presence of a tegillum could not be confirmed, although some form of umbilical covering appears to be present in Fig. 4.

DISTRIBUTION. Trinidad (Brönnimann 1952).

RANGE. Late Maastrichtian, according to Masters (1977).



Figs 12–15, 17 *Plummerita kennerleyi* sp. nov. Paratypes, from sample CRB 56, Yunguilla Formation, Cuenca Basin, south Ecuador. Figs 12, 14, P 50836. Fig. 12, tubulospine on final chamber with end broken to show hollow centre, ×655; Fig. 14, detail of final chamber showing pores and well-developed costae, ×380. Figs 13, 15, P 50838. Detail of tubulospines on second and third chambers of final whorl, ×680 and ×380, respectively. Fig. 17, P 50839. Vertical thin section, orientated through one of pair of tubulospines on final chamber, ×135. Note tubulospine is a hollow extension of chamber.

Fig. 16 *Plummerita hantkeninoides* (Brönnimann). P 50829. Topotype, detail of tubulospine, ×425. Guayaguayare Formation, SE Trinidad.

Plummerita kennerleyi sp. nov.
Figs 12–15, 17–31

DIAGNOSIS. A moderately inflated species of *Plummerita* with 4–5 chambers in the final whorl. Tubulospines developed only in last three chambers, paired, one at each angle of the periphery and oblique to the plane of coiling. Ornament of meridionally arranged ridges strongly developed.

NAME. After the late J. Brian Kennerley, former Head of the I.G.S. (Overseas Division) Survey Team in Ecuador.

HOLOTYPE. P 50835, sample SC 159, Yunguilla Formation, Cuenca Basin.

MATERIAL. 71 specimens, samples CRB 56–58, SC 158, 159, Yunguilla Formation, Cuenca Basin; 86 specimens, samples JW 411, 412, Río Playas Formation, Río Playas Basin, S. Ecuador (see Fig. 1).

DESCRIPTION. (Holotype). Test a low trochospire consisting of about two whorls. Outline in spiral and umbilical views lobulate then tubulospinate; five chambers in final whorl, subglobular at first, gradually increasing in size, with last two chambers each produced into two tubulospines at opposite angles to the mid-line of the periphery. Lower periphery rounded in edge view, upper margin tubulospinose. Sutures moderately depressed, curved. Wall calcareous, finely perforate, test surface ornamented by strong, meridionally arranged ridges which extend to the tubulospines. Umbilicus shallow, aperture appears to be an interiomarginal, umbilical–extra-umbilical arch; tegillum not preserved.

DIMENSIONS. Holotype: maximum test diameter (excluding tubulospines) 0·25 mm; (including tubulospines) 0·28 mm; maximum width (including tubulospines) 0·17 mm.

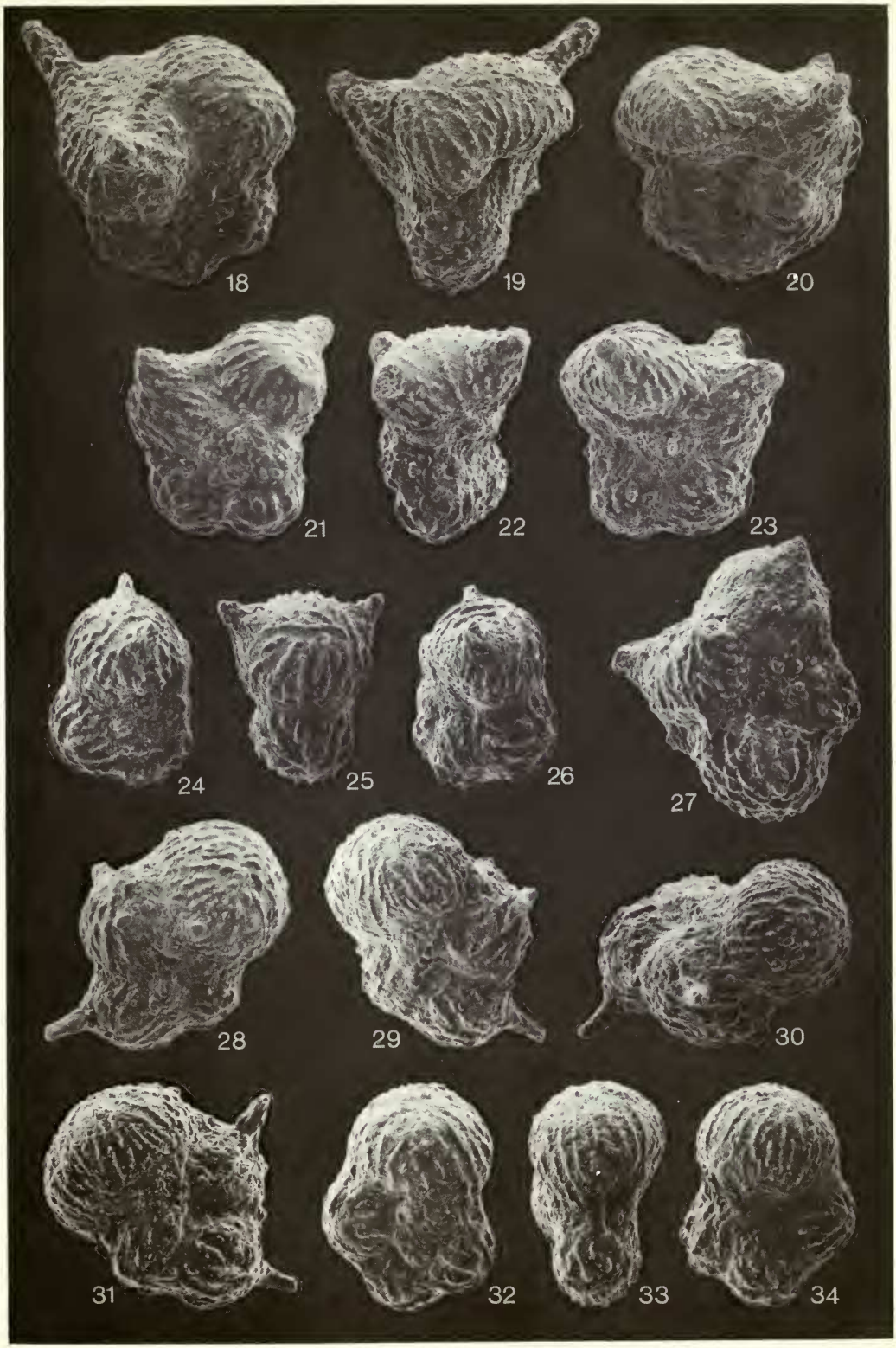
VARIATION. (Paratypes). The maximum test diameter of the four figured paratypes, P 50834 and P 50836–P 50838, varies 0·22–0·33 mm (excluding tubulospines) and 0·25–0·34 mm (including tubulospines); the greatest width (including tubulospines) varies 0·17–0·26 mm. The number of chambers in the final whorl varies between four and five (figured and unfigured paratypes); all specimens have about two whorls.

The paired tubulospines are developed only on the last two or three chambers; their length varies considerably (Figs 18–31) and in extreme cases they become antler-like (Figs 18–20). Four tubulospines occur on the final chamber of one unfigured specimen. The apparent presence of a single tubulospine in some specimens (Figs 28–31) is due to one of the pair being broken off at the base. The last-formed chamber sometimes lacks tubulospines and is globose (Figs 18–20).

REMARKS. *Plummerita kennerleyi* sp. nov. differs from *P. hantkeninoides* (Brönnimann) and *P. reicheli* (Brönnimann) in being much more inflated and in possessing paired tubulospines; the tubulospines in *P. hantkeninoides* and *P. reicheli* are single and are situated in the plane of coiling. *P. kennerleyi* and *P. hantkeninoides* are ornamented by meridionally arranged costae which are longer and much more strongly developed in the former than in the latter, at least in the material available. *P. reicheli* has discrete, coarse blunt spines rather than ridges.

Figs 18–31 *Plummerita kennerleyi* sp. nov., all ×135. Figs 18–23, from sample SC 159, Yunguilla Formation, Cuenca Basin, south Ecuador. Figs 18–20, P 50834. Paratype, spiral, edge (apertural) and umbilical views. Figs 21–23, P 50835. **Holotype**, spiral, edge (apertural) and umbilical views. Figs 24–26, from sample CRB 56, Yunguilla Formation, Cuenca Basin, south Ecuador. P 50836. Paratype, spiral, edge (abapertural) and umbilical views. Fig. 27, from sample JW 412, Río Playas Formation, Río Playas Basin, south Ecuador. P 50837. Paratype, spiral view. Figs 28–31, from same sample as Figs 24–26. P 50838. Paratype, spiral, umbilical and two oblique umbilical views; note possible remains of tegillum in Figs 29–31.

Figs 32–34 *Rugoglobigerina rugosa* (Plummer). P 50840. Spiral, edge (apertural) and umbilical views. Specimen included for comparison with *P. kennerleyi* sp. nov. Sample CRB 56, Yunguilla Formation, Cuenca Basin, south Ecuador. ×135.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The tubulospines now shown to occur in *Plummerita* species are closely analogous to those found in another, but not closely related, Cretaceous planktonic genus, *Schackoina*. In this genus are found species which are both single-tubulospinose chambered, such as *S. cenomana* (Schacko), and multi-tubulospinose chambered, such as *S. multispinata* (Cushman & Wickenden). Cushman & Wickenden (1930) proposed several growth stages to account for the varying number of tubulospines in *S. multispinata*. The small forms, with a single tubulospine per chamber, they assumed to be juveniles, while larger individuals with several tubulospines per chamber they regarded as adult or gerontic growth stages. Since *Plummerita hantkeninoides* and *P. kennerleyi* are of similar size and do not occur together it is unlikely that they are growth stages of the same species; furthermore, the latter never possesses chambers which are radially elongate in the plane of coiling, even in very small individuals. The two species must have evolved separately in the Maastrichtian from rugoglobigerine ancestors, probably *Rugoglobigerina rugosa* (Plummer) in the case of *P. kennerleyi* (compare Figs 17–31 with Figs 32–34, both from Ecuador). *P. kennerleyi* may prove to be a geographically restricted form. At present it is not possible to suggest why its curious morphology developed.

A definite tegillum has not been found on any specimens of *P. kennerleyi*. This is, however, thought to be a preservation defect since specimens of *R. rugosa* from the same samples (Figs 32–34) also lack this feature. As the most fragile of apertural coverings, it is generally only preserved in specimens obtained from soft clays and marls (see Smith & Pessagno 1973), and would not be expected to survive extraction from compacted shales.

DISTRIBUTION. Known only from the Yunguilla Formation (Cuenca Basin) and Río Playas Formation (Río Playas Basin), S. Ecuador.

RANGE. Maastrichtian (probably mid or late).

Plummerita reicheli (Brönnimann)
Fig. 11

1952 *Rugoglobigerina reicheli reicheli* Brönnimann: 18; pl. 3, figs 10–12; text-figs 4a–m, 5a–i.
1977 *Rugoglobigerina* (?) *reicheli* Brönnimann; Masters: 621 (*q.v.* for synonymy).

MATERIAL. Four paratypes from the Guayaguayare Formation, Guayaguayare Well no. 163, core 19, depth 5588–5598 feet (1703–1706 m), SE Trinidad.

DIMENSIONS. Figured specimen: maximum test diameter (including tubulospines) 0·31 mm; maximum width 0·18 mm.

REMARKS. Brönnimann (1952) originally described three subspecies of *R. reicheli*, namely *R. reicheli reicheli*, *R. reicheli hexacamerata* and *R. reicheli pustulata*. The second subspecies is now considered a distinct species of its own, while according to Masters (1977) the last-named form is a junior synonym of *R. rugosa* (Plummer).

The species is here placed in *Plummerita* as the paratypes possess radially elongate chambers and tubulospines in the final whorl. Ornament consists of meridionally arranged, coarse, blunt, discrete spines or nodes, rather than ridges as in *P. hantkeninoides* and *P. kennerleyi*. Exceptionally well preserved specimens akin to some forms of this species originally figured by Brönnimann (1952) are illustrated by Smith & Pessagno (1973 : pl. 26); they show that a tegillum does exist in this taxon, and therefore probably in the genus as a whole.

DISTRIBUTION. Trinidad (Brönnimann 1952); Mexico; Texas and Arkansas, U.S.A. (Pessagno 1967, Smith & Pessagno 1973).

RANGE. Mid to late Maastrichtian (according to Smith & Pessagno 1973); late Maastrichtian only (according to Masters 1977).

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